Chapter 5
Slurry Walls

5-1. General.

The design and function of slurry walls and specific uses of cement/bentonite walls are discussed in the chapter's first section. The second portion of the chapter is a hazard analysis with controls and control points listed.

5-2. Technology Description.

a. Design and Function of Slurry Walls.

A slurry wall is an in-ground physical containment device designed to isolate contaminant source zones and groundwater plumes from the surrounding environment. Contaminated soil, wastes, and/or groundwater can be physically isolated within surrounding low-permeability barriers by constructing a vertical trench excavated down to and keyed into a deeper confining layer, such as a low-permeability clay or shale and filling the trench with a slurry. Slurry walls usually consist of a soil, bentonite, and/or cement mixture. The slurry mix hydraulically shores the trench to prevent collapse during installation and forms a permeation barrier to prevent the escape of contaminants from the contained area. As the excavation continues, additional slurry is added, and the process continues until the depth and length needed is completed. A schematic diagram of a slurry wall configuration is presented in Figure 5-1.

Slurry walls are commonly used subsurface barriers because they are a relatively inexpensive means of reducing groundwater flow in unconsolidated earth material and are also useful for sites where present technologies can not effectively or economically treat contaminant sources. Cement and bentonite construction of a wall can adsorb and retard the escape of heavy metals and larger organic molecules but can not completely stop water movement. Consequently, slurry walls are either "stop-gap" measures or are typically accompanied (as illustrated in Figure 5-1) by pump-and-treat systems. Often the enclosed area is capped or covered to prevent additional infiltration of water behind the wall.

Slurry walls are also used to direct or funnel the flow of groundwater to pump-and-treat well arrays or in-situ treatment areas, such as a reactive wall or biosparging array. Soil/bentonite walls have been used for decades for groundwater control in conjunction with large dam projects. However, the ability of these walls to withstand long-term permeation by many contaminants is unknown. Evidence indicates that

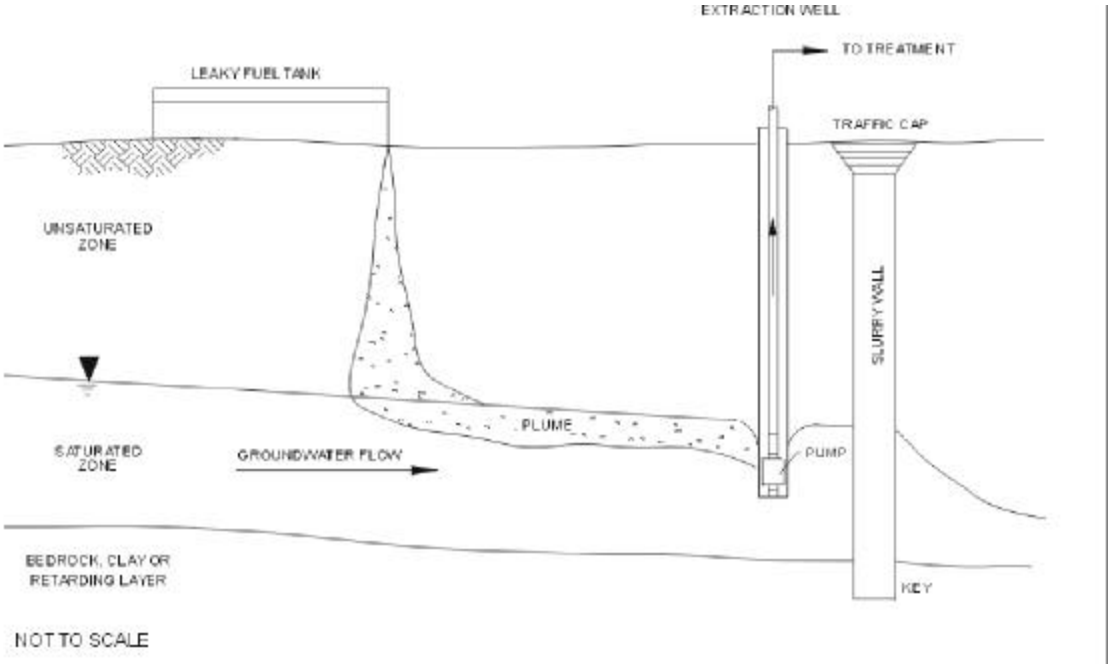

FIGURE 5-1. SLURRY WALLS

soil/bentonite backfills are not able to withstand attack by strong acids and bases, strong salt solutions, and some organic chemicals.

b. Cement/Bentonite Walls.

Cement/bentonite walls are more expensive than soil/bentonite walls and are generally used where: (1) there is no room to mix and place soil-bentonite backfills; (2) increased mechanical strength is required; or (3) extreme topography conditions (slopes) make it impractical to grade a site level. Cement/bentonite slurry walls are limited in their use by their higher permeability and their narrow range of chemical compatibilities (more susceptible to attack by sulfates, strong acids or acid bases, and other highly ionic substances).

5-3 Hazard Analysis.

Principal unique hazards associated with the slurry walls, methods for control, and control points are described below.

a. Physical Hazards.

(1) Equipment Hazards.

Description: During soil excavation, workers may be seriously injured or killed by heavy equipment such as front-end loaders and backhoes. This equipment may also cause a noise hazard to workers.

Control: Controls for equipment hazards include

- Use heavy equipment with a backup alarm to alert workers.
- Approach operating equipment from the front and within view of the operator, preferably making eye contact.
- Wear hearing protection around operating equipment.

CONTROL POINT: Construction

(2) Utility or Underground Structure Hazards.

Description: Fire, electrocution, or explosion hazards may exist during installation of the slurry wall if a backhoe ruptures an underground utility, such as sewers, pipelines, or electrical or gas lines. Abrupt equipment stoppages due to contact with underground structures, such as foundations, may cause a dangerous condition leading to equipment-related accidents.

Control: Controls for utility and underground structure hazards include

- Identify the location of all below- and above-ground utilities prior to excavation by contacting local utilities and public works personnel. When there is any doubt or uncertainty, perform a utility survey, probe with a metal rod, or hand excavate prior to excavation to determine the exact location of utilities. Once utilities are located, careful excavation by backhoe may be allowed.
- Post an observer to the side to observe and supervise when raising a drill mast or other equipment.

CONTROL POINT: Design, Construction

(3) Trench Hazards.

Description: Open excavations may pose fall hazards to workers while performing activities near the trench. The trench wall may collapse or the worker may fall into the trench while performing trench depth measurements or sample collection.

Control: Controls for trench hazards include

- Inspect the excavation each day to ensure the stability of the walls.
- Limit worker activities near the excavation and only approach wearing fall protection, such as a safety harness and/or attached lanyard.
- Equip all personnel crossings with handrails.

CONTROL POINT: Construction, Operations

(4) Steam Pressure Washing.

Description: Steam pressure washing of equipment may expose workers to thermal or burn hazards, eye hazards due to flying projectiles dislodged during pressure washing, slip hazards from wet surfaces, and noise hazards.

Control: Controls for steam pressure washing include
- Use insulated gloves (e.g., silica fabric gloves).
- Wear safety goggles and hearing protection.
- Wear slip-resistant boots.
- Drain water away from the decontamination operation into a tank or pit.
- Drain walking surfaces and keep free of standing liquids or mud.

CONTROL POINT: Construction, Operations

(5) UV Radiation.
Description: During site activities, workers may be exposed to direct and indirect sunlight and corresponding UV radiation. Even short-term exposure to sunlight can cause burns and dermal damage. Hot and humid conditions may also result in heat stress, which can manifest itself as heat exhaustion and heat stroke.

Control: Controls for UV radiation include
- Minimize direct sun exposure by wearing sun hats, long-sleeved shirts, full-length pants, and by applying UV barrier sunscreen.
- Shade work and break areas if possible.
- Minimize exposure to heat stress by taking frequent breaks, drinking adequate fluids, and performing work during the early morning and late afternoon hours.

CONTROL POINT: Construction, Operations

(6) Electrocution Hazards.
Description: Workers may be exposed to electrocution hazards when working around electrical utilities such as overhead power lines.

Control: Controls for electrocution hazards include
- Verify the location of overhead power lines, either existing or proposed, in the pre-design phase.
- Keep all lifting equipment, such as cranes, forklifts, and drilling rigs at least 10 feet from the power line according to Occupational Safety and Health Administration (OSHA) regulation 29 CFR 1926.550 and EM 385-1-1, Section 11.E.

CONTROL POINT: Design, Construction, Operations

(7) Heavy Equipment Hazards.
Description: The heavy equipment (small and large) used for site operations may roll over on steep slopes or unstable ground, seriously injuring the

operator. Trucks loaded with backfill can back up too far and become stuck in the trench.

Control: Controls for heavy equipment hazards include
- Design the angle of the slope to minimize the potential for roll-over.
- Maintain safe operating conditions for equipment during construction (construction contractor).
- Use heavy equipment with roll-over protective devices (ROPS) and do not operate on steep slopes or unstable ground.

CONTROL POINT: Design, Construction, Operations

(8) Traffic Hazards.
Description: During the implementation of field activities, equipment and workers may come in close proximity to traffic. Also, drilling rigs and other equipment may need to cross or use public roads. The general public may be exposed to traffic hazards and the potential for accidents during loading and transporting soil.

Control: Controls for traffic hazards include
- Post warning signs according to the criteria of the Department of Transportation Manual on Uniform Traffic Devices for Streets and Highways.
- Develop a traffic management plan before remediation activities begin to help prevent accidents involving site trucks and automobiles. EM 385-1-1, Section 21.I.10 provides plan details.

CONTROL POINT: Design, Construction, Operations

(9) Predesign Field Activities.
Description: Predesign field activities associated with subsequent construction may include surveying, biological surveys, soil gas surveys, geophysical surveys, trenching, drilling, stockpiling, contaminant groundwater sampling, and other activities. Each of these field activities may expose the survey personnel to physical, chemical, radiological, and biological hazards.

Control: Controls for hazards resulting from predesign field activities include
- Prepare an activity hazard analysis for predesign field survey activities. EM 385-1-1, Section 1.A provides guidance on developing an activity hazard analysis.
- Train workers in hazards identified.

CONTROL POINT: Design

b. Chemical Hazards

Slurry/Contamination Hazards.
Description: During excavation/mixing/installation operations, workers may be exposed to inhalation/ingestion/dermal hazards from caustic irritants such as Portland cement, airborne dusts, volatile organic compounds (VOCs), metals, or free silica from soil/bentonite mixtures and waste materials. Eye exposure may occur resulting in scratching and scarring of eyes.

Control: Controls for contamination hazards include

- Reduce airborne dusts by periodically applying water, amended water, or emission-suppressing foams to the active excavation and mixing areas. The addition of foam to control vapors may also create a slip and fall hazard. Workers should not walk on areas to which foam has been applied.
- Minimize the amount of soil agitation during mixing operations.
- Erect wind screens and portable surface covers.
- Use the proper types of PPE: an air-purifying respirator equipped with approved HEPA (N100, R100, P100) filters for particulates, OV cartridges for vapors, or combination filter/cartridges for dual protection, and eye protection.
- Use experienced workers, frequent health and safety meetings, decontamination stations, and other standard procedures.

CONTROL POINT: Design, Construction, Operations

c. Radiological Hazards.

Radioactive Material.
Description: Radiological materials may have been buried or naturally occurring radioactive material (NORM) may be present in the excavated soils, sludge, and groundwater. Some radioactive materials may present an external hazard. All radioactive materials may present an internal exposure hazard through inhalation or ingestion. *Note that this may be a rare hazard to encounter using this remediation technology*.

Control: Controls for radioactive materials include

- Test excavated soil, sludge, or groundwater to determine if radioactive materials are present.
- Consult a qualified health physicist if any radioactive material above background levels is found. Consultation should result in determination of exposure potential, any necessary engineered controls, or PPE required.

CONTROL POINT: Design, Construction, Operations

d. Biological Hazards.

(1) Biological Contaminants.

Description: At those sites involving medical wastes or sewage sludge, microorganisms in the soil may cause exposure hazards during the soil mixing and waste stabilization activities. Workers may be exposed to inhalation/ingestion/dermal contact with pathogens, such as *Coccidioides sp.*, *Histoplasma sp.*, and *Mycobacterium sp.* if contaminated dusts become airborne.

Control: Controls for biological contaminants include

- Reduce generation of airborne microbe-contaminated dust with the periodic application of water, amended water, or emission-suppressing foams to the active excavation and mixing areas. The addition of foam to control vapors may also create a slip and fall hazard. Workers should not walk on areas where foam has been applied.
- Minimize the amount of soil agitation during mixing operations.
- Erect wind screens and use portable surface covers.
- Use proper types of PPE: an air-purifying respirator with HEPA (N100, R100, P100) filter/cartridge.
- Use experienced workers, repeated health and safety meetings, decontamination stations, and other standard procedures.

CONTROL POINT: Design, Operations

(2) Pests.

Description: Workers may be exposed to a wide array of biological hazards, including snakes, bees, wasps, ticks, hornets, and rodents, during any phase of remediation. The symptoms of exposure vary from mild irritation to anaphylactic shock and death. Deer ticks may cause Lyme disease. Rodents can transmit Hanta virus.

Control: Controls for pests include

- Perform periodic inspections of the site to identify stinging insect nests and to check for snakes and rodents.
- Use professional exterminating companies if necessary.
- Use tick and insect repellents for exposure control. Workers should check their skin and clothing for ticks periodically throughout the workday.

CONTROL POINT: Construction, Operations, Maintenance